SANYO

# Service Manual

FILE No.

Ultra-Low Temperature Freezer

**MDF-594**

**MDF-594AT**

**MDF-593(N)**

SANYO Electric Co., Ltd.
Biomedical Division

**RoHS**

This product does not contain any hazardous substances prohibited by the RoHS Directive.
(You will find 'RSF' mark near the rating plate on the RoHS compliant product.)

**WARNING**

* You are requested to use RoHS compliant parts for maintenance or repair.
* You are requested to use lead-free solder.

SM9910107

## Effective models

This service manual is effective following models.

| Model name | Product code | Voltage and Frequency | |
|---|---|---|---|
| MDF-594 | 823 197 54 | 230/240V | 50Hz |
| | | | |
| MDF-594AT | 823 197 74 | 230/240V | 50Hz |
| | | | |
| MDF-593(N) | 823 195 57 | 220V | 50Hz |
| | | | |

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# Specifications

■Structural specifications

| Model | MDF-594/MDF-593(N) | MDF-594AT |
|---|---|---|
| Name | Ultra-low Temperature Freezer | |
| External dimensions | W2010 × D770 × H1070 (mm) | |
| Internal dimensions | W1280 × D500 × H762 (mm) | |
| Effective capacity | 487 L | |
| Exterior | Painted steel | |
| Interior | Stainless steel | |
| Door | Painted steel | |
| Insulation | Rigid polyurethane foamed-in place | |
| Monitoring hole | On left side, ID;φ40mm | |
| Compressor | High stage side; 1100W Low stage side; 1100W | |
| Evaporator | Tube on sheet type | |
| Condenser | High stage side; fin and tube type<br>Low stage side; shell and tube type | |
| Refrigerant | High stage side; R407D<br>Low stage side; R-508 | |
| Refrigerating oil | Ze-NIUS32SA | |
| Power supply | Local voltage | |
| Battery | For power failure alarm;<br>Nickel-cadmium battery<br>DC6V, 270mAh | For power failure alarm;<br>Nickel-cadmium battery<br>DC6V, 270mAh<br>For back-up system;<br>Lead storage battery<br>DC6V, 4Ah×4pcs |
| Weight | 291 kg | 301 Kg |
| Back-up system | None | Liquid CO2 |
| Accessories | 1 set of key, 1 scraper | 1 set of key, 1 scraper,<br>1 connect tube for back-up system<br>1 dry cell, 6 recording chart rolls,<br>2 recording pens (cartridge) |
| Option | Aluminum container; MDF-59SC<br>Inventory rack; IR213C, IR309C<br>Temperature recorder; MTR-85H<br>Back-up system; CVK-UB2,<br>CVK-UB2(I): LCO2 | Aluminum container; MDF-59SC<br>Inventory rack; IR213C, IR309C |

■Control specifications

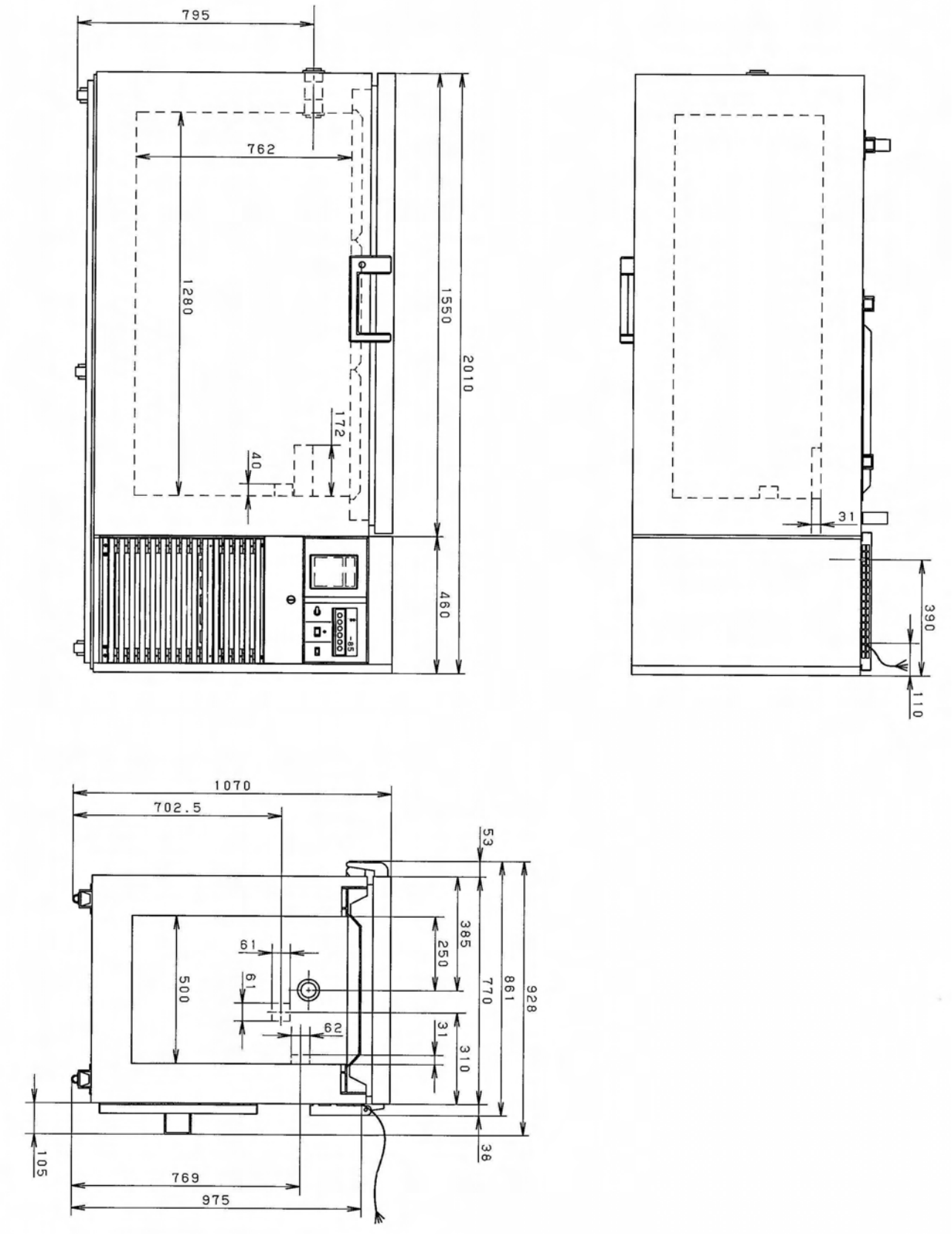
| Model | | MDF-594/594AT/593(N) |
|---|---|---|
| Cooling performance | | Center part of freezing room; -86℃（AT+30℃, no load） |
| Temperature controller | | Microprocessor control system |
| Temperature sensor | | Pt.100Ω |
| Temperature display | | Digital display |
| Alarm | High temp. | Setting range; +10℃ or +15℃（Initial; +10℃）<br>ALARM lamp and display flash, intermittent buzzer tone emitted with 12min. delay<br>Remote alarm contact; Normal Open, Normal Close<br>Rated contact capacity; DC30V、2A<br>Contact turns over with 12min. of delay |
| | Filter check | FILTER lamp flashes and intermittent buzzer tone emitted to inform the condenser filter clogged. |
| | Power fail. | At power failure and power cord is disconnected,<br>ALARM lamp flashes, intermittent buzzer tone emitted and remote alarm contact turns over. |
| | Remote alarm | Remote alarm terminal; 3P:DC30V, 2A<br>NC-COM, NO-COM |
| Control panel | | Lamp; ALARM, FILTER CHECK<br>Alarm buzzer stop key; BUZZER<br>Power switch; POWER<br>Battery switch<br>Mode setting key; PV/SV<br>Enter key; ENTER<br>Digit shift key;▶▶<br>Numerical value shift key; ▲▲<br>Alarm test key; ALARM<br>CO2 Back-up switch; CO2 BACK UP … AT type only<br>CO2 Back-up test switch; TEST … AT type only |
| Self diagnosis function | | When any error is occurred in chamber temperature, filter sensor, cascade sensor and AT sensor, error code and PV are alternately displayed.<br>ALARM lamp flashes, remote alarm contact turns over and intermittent buzzer tone emitted. |

| | |
|---|---|
| Compressor protection | When cascade sensor is equal or lower than -34℃, low stage side compressor turns ON.<br>When cascade sensor is equal or higher than -18℃, low stage side compressor turns OFF.<br>When filter sensor is equal or higher than +60℃, high stage side compressor turns OFF.<br>When filter sensor is equal or lower than AT sensor temperature + 10℃, high stage compressor turns ON.<br>Overload relay |

■Performance specifications

| | | | | |
|---|---|---|---|---|
| Cooling performance | Center part of freezing room; -86℃（AT30℃, no load） | | | |
| Temperature control range | -20℃～-86℃ | | | |
| Power source | 220V, 50Hz | 220V, 60Hz | 230V, 50Hz | 240V, 50Hz |
| Rated power consumption | 990W | 1120W | 1050W | 1090W |
| Noise level | 50dB <A> (background noise; 20dB) | | | |
| Maximum pressure | 1.7 MPaG | | | |

# Dimensions


795
762
1280
1550
2010
172
40
460
31
390
110
1070
702.5
53
385
250
61
61
500
770
861
928
62
31
310
38
105
769
975

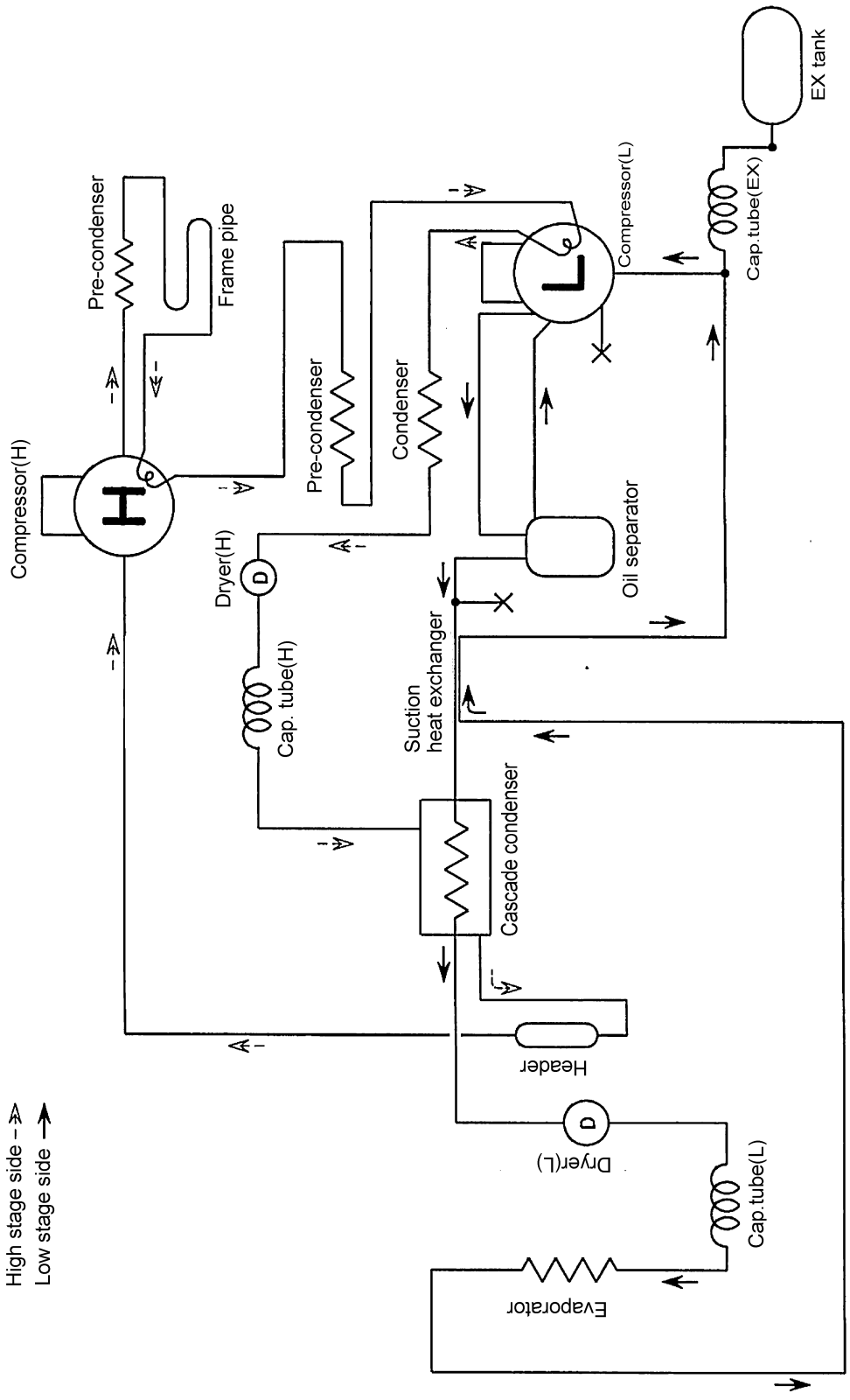
# Cooling unit parts

**<MDF-594/594AT/593(N)>**

| Item | Specifications | | |
|---|---|---|---|
| | H side | L side | |
| **Compressor** | | | |
| 230/240V, 50Hz | Type: KS370J1NS-4A1 Compressor code: 7FB-0-M101-001-05 | | |
| 220V, 50Hz | Type: KS370J1NS-4A Compressor code: 7FB-0-M101-001-04 | | |
| 220V, 60Hz | Type: KS370J1NS-7A Compressor code: 7FB-0-M101-001-06 | | |
| Refrigerant oil | Ze-NIUS32SA<br>Charged q'ty: 850cc | Ze-NIUS32SA<br>Charged q'ty: 850cc | |
| Cooling system | Forced air cooling (partially)<br>Oil cooler | Forced air cooling (partially)<br>Oil cooler | |
| **Condenser** | | | |
| Type | Fin and tube | Cascade condenser | |
| Condenser | 12 columns x 3 lines P6.35mm<br>Fin 49pcs. | Coil pipe $\phi$6.35mm | |
| Pre-condenser | $\phi$6.35 x 8 columns W 420mm | —— | |
| Frame pipe | $\phi$6.35mm | —— | |
| **Evaporator**<br>Type | Cascade condenser<br>Shell and tube $\phi$80mm x 2 | Tube on sheet $\phi$9.52 | |
| **Capillary tube** | | | EX capillary |
| Resistance<br>PSI・kg/cm$^2$ | 56 PSI/G | 78 PSI/G | 34 PSI |
| Length (mm) | 1300 | 3000 | 500 |
| Outer diameter (mm) | $\phi$2.4 | 2.4 | 2.4 |
| Inner diameter (mm) | $\phi$1.2 | 1.2 | 1.2 |
| **Refrigerant** | R-407D Charged q'ty: 428g | R-508(TP5R3) Charged q'ty: 230g | |
| **Oil additive** | n-Pentane<br>Charged q'ty: 27g | n-Pentane<br>Charged q'ty: 38g | |
| **Dryer** | 4A-XH-9 Charged q'ty: 18g | 4A-XH-6 Charged q'ty: 58g | |
| **Condensing fan** | $\phi$230 mm、4 blades<br>Material: ABS | | |
| **Condensing fan motor** | Type: SE4-E11L5P | | |
| **Oil separator** | —— | SPK-0S02S0 | |

# Refrigeration Circuit

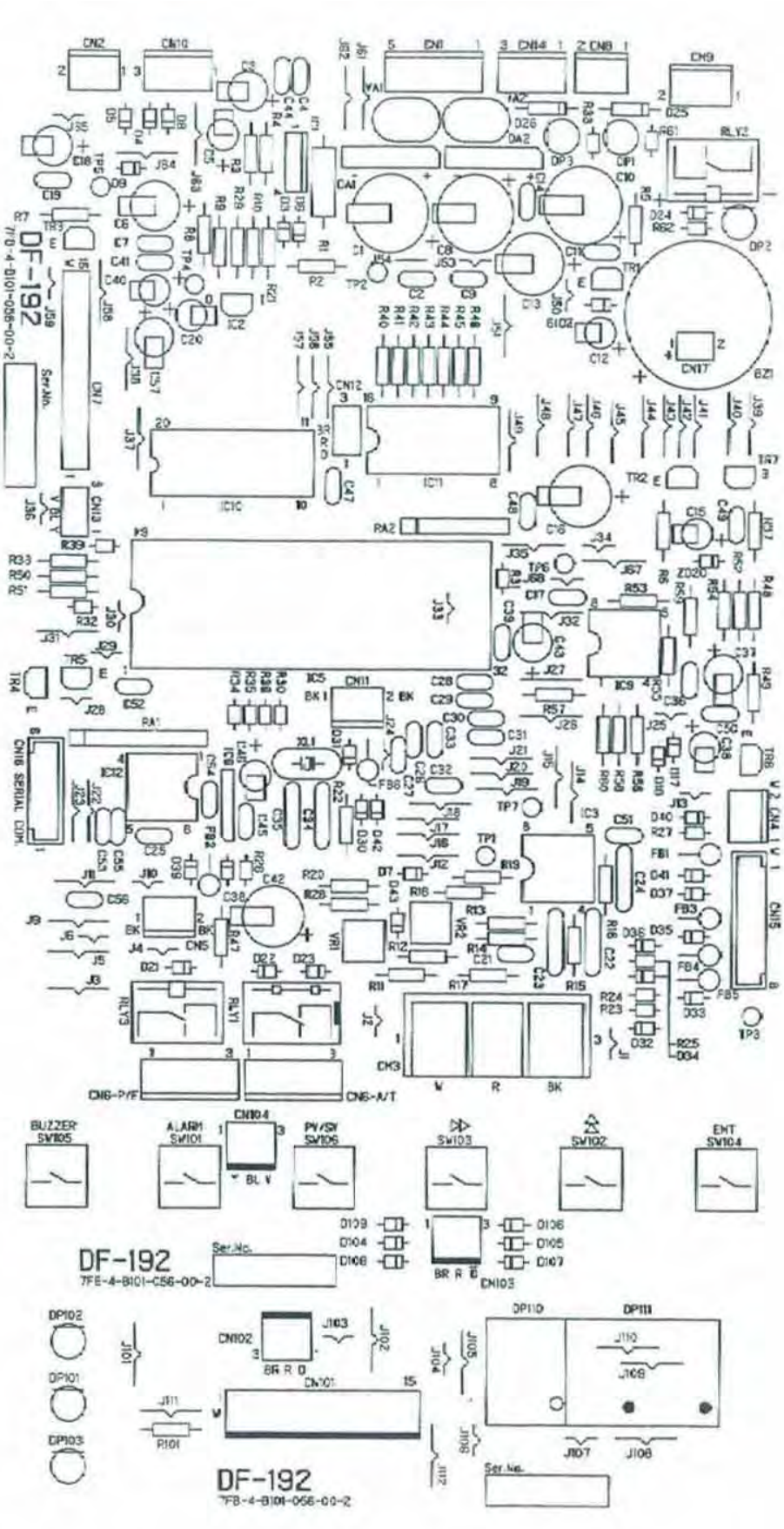
## Secondary refrigeration circuit



## Electric parts

| MDF-594/594AT/593(N) | | 220V, 60Hz | 220V, 50Hz | 230/240V, 50Hz |
|---|---|---|---|---|
| Compressor (H), (L) | Type | KS370J1NS-7A | KS370J1NS-4A | KS370J1NS-4A1 |
| | Parts code | 7FB 0 M101 001 06 | 7FB 0 M101 001 04 | 7FB 0 M101 001 05 |
| | Rated voltage | 220V, 60Hz | 220/230V, 50Hz | 230/240V, 50Hz |
| | Winding resistance (C-S) | 1.64Ω | 2.53Ω | 2.53Ω |
| | Winding resistance (C-R) | 3.35Ω | 4.8Ω | 4.8Ω |
| Starting relay (H), (L) | Type | AMVL-300A | AMVL-300A | AMVL-300A |
| | Pick-up voltage | 215~247VAC | 185~217VAC | 185~217VAC |
| | Drop-out voltage | 69~132VAC | 60~120VAC | 60~120VAC |
| | Parts code | 626 100 1503 | 626 100 1503 | 926 100 1504 |
| Overload relay (H), (L) | Type | MRA999539201 | MRA999539201 | MRA999539201 |
| | Action to temp. (no current) | ON:69±10℃ OFF:135±10℃ | ON:69±10℃ OFF:135±10℃ | ON:69±10℃ OFF:135±10℃ |
| | Action to current (AT25℃) | 29.5A | 22.5A | 22.5A |
| | Operation time | 6~16 sec. | 6~16 sec. | 6~16 sec. |
| | Parts code | 624 226 3173 | 624 226 3166 | 924 226 3167 |
| Starting capacitor (H), (L) | Type | 160UF, 250V | 100UF, 250V | 100UF, 250V |
| Running capacitor (H), (L) | Type | 25UF, 400VAC | 25UF, 400VAC | 25UF, 400VAC |
| Condensing fan motor | Type | SE4-E11L5P | SE4-E11L5P | SE4-E11L5P |
| | Rated voltage | 220-240V | 220-240V | 220-240V |
| | Parts code | 624 224 0167 | 624 224 0167 | 924 224 0168 |
| Cap.tube heater | Rated voltage | 100V, 12W | 100V, 12W | 100V, 12W |
| | Resistance(25℃) | 833Ω | 833Ω | 833Ω |
| | Parts code | 624 183 8952 | 624 183 8952 | 924 183 8953 |
| Temp. control relay (H) | Type | G4F-11123T | G4F-11123T | G4F-11123T |
| | Rated voltage | 20A, 12VDC | 20A, 12VDC | 20A, 12VDC |
| | Parts code | 624 173 2397 | 624 173 2397 | 924 173 2398 |
| Temp. control relay (L) | Type | G4F-11123T | G4F-11123T | G4F-11123T |
| | Rated voltage | 20A, 12VDC | 20A, 12VDC | 20A, 12VDC |
| | Parts code | 624 173 2397 | 624 173 2397 | 924 173 2398 |
| Breaker switch | Type | BAM215131 | BAM215131 | BAM215131 |
| | Rated voltage | 250V, 15A | 250V, 15A | 250V, 15A |
| | Parts code | 624 215 4235 | 624 215 4235 | 924 215 4236 |
| Power transformer for PCB | Type | A-3578 | A-3578 | A-3578 |
| | Rated voltage | 6.2VA | 6.2VA | 6.2VA |
| | Parts code | 624 171 0279 | 624 171 0279 | 924 171 0280 |
| Power transformer | Type | ATR-C50 | ATR-C50 | ATR-C50 |
| | Rated voltage | 200-240V | 200-240V | 200-240V |
| | Parts code | 624 006 0408 | 624 006 0408 | 924 006 0409 |
| Battery switch | Type | SLE6A2-5 | SLE6A2-5 | SLE6A2-5 |
| | Rated voltage | 4A, 250VAC | 4A, 250VAC | 4A, 250VAC |
| | Parts code | 624 213 1472 | 624 213 1472 | 924 213 1473 |
| Battery | Type | 5N-270AA | 5N-270AA | 5N-270AA |
| | Rated voltage | 6V, 270MAH | 6V, 270MAH | 6V, 270MAH |
| | Parts code | 624 171 0272 | 624 171 0272 | 924 171 0273 |
| Temp. sensor | Type | PT-100Ω | PT-100Ω | PT-100Ω |
| Cascade sensor | Type | 502AT | 502AT | 502AT |
| | Rated voltage | 5KΩ, 25℃ | 5KΩ, 25℃ | 5KΩ, 25℃ |
| Filter sensor | Type | 502AT | 502AT | 502AT |
| | Rated voltage | 5KΩ, 25℃ | 5KΩ, 25℃ | 5KΩ, 25℃ |
| AT sensor | Type | 502AT | 502AT | 502AT |
| | Rated voltage | 5KΩ, 25℃ | 5KΩ, 25℃ | 5KΩ, 25℃ |
| Solenoid valve (AT type only) | Type | X8264D9 | X8264D9 | X8264D9 |
| | Rated voltage | 24VDC | 24VDC | 24VDC |
| | Parts code | 624 226 8567 | 624 226 8567 | 924 226 8568 |
| Back up switch (AT type only) | Type | HLS208N | HLS208N | HLS208N |
| | Rated voltage | 250VAC, 6A | 250VAC, 6A | 250VAC, 6A |
| | Parts code | 624 169 9690 | 624 169 9690 | 924 169 9691 |
| Test switch (AT type only) | Type | 8R2021-Z | 8R2021-Z | 8R2021-Z |
| | Rated voltage | 3A, 125VAC | 3A, 125VAC | 3A, 125VAC |
| | Parts code | 624 226 6051 | 624 226 6051 | 924 226 6052 |

# Components on PCB



# Specifications of sensor

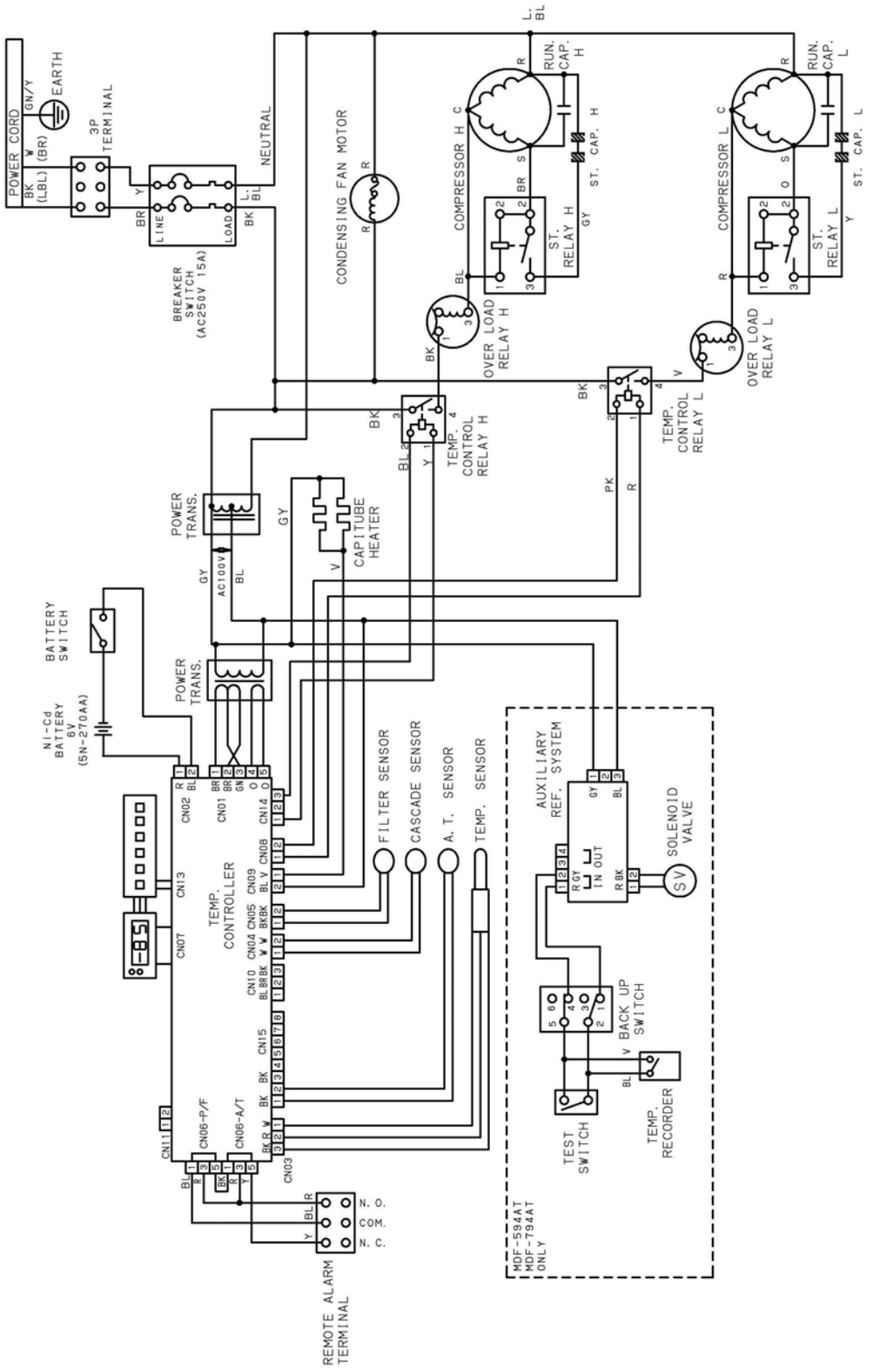
■Temperatures in temperature sensor (502AT-1) and resistance values

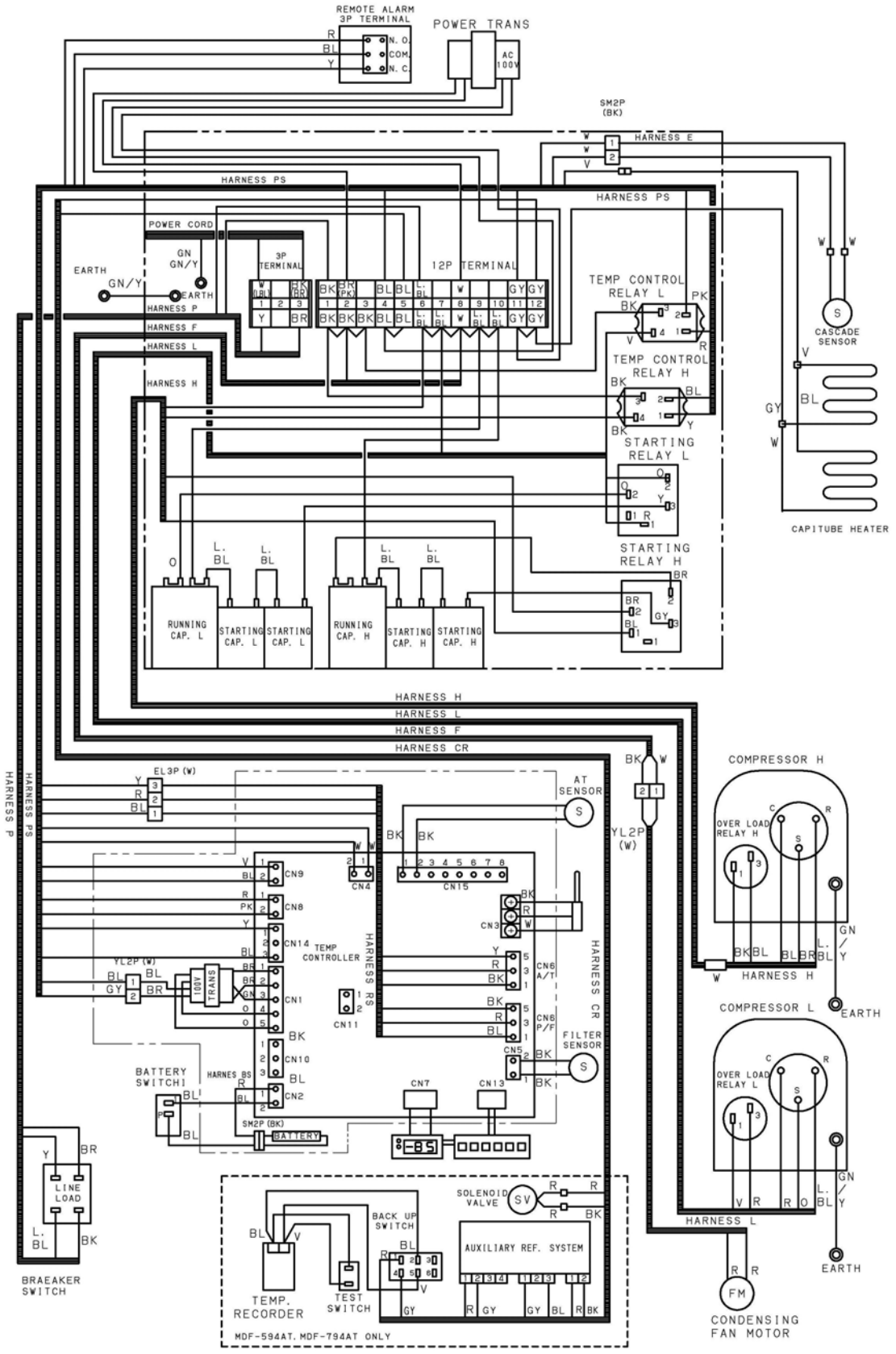
| ℃ | kΩ | ℃ | kΩ | ℃ | kΩ | ℃ | kΩ |
|---|---|---|---|---|---|---|---|
| −50 | 154.5 | −36 | 71.80 | −22 | 35.65 | 0 | 13.29 |
| −49 | 145.9 | −35 | 68.15 | −21 | 33.99 | 5 | 10.80 |
| −48 | 137.8 | −34 | 64.71 | −20 | 32.43 | 10 | 8.84 |
| −47 | 130.2 | −33 | 61.48 | −19 | 30.92 | 15 | 7.20 |
| −46 | 123.1 | −32 | 58.43 | −18 | 29.50 | 20 | 6.01 |
| −45 | 116.5 | −31 | 55.55 | −17 | 28.14 | 25 | 5.00 |
| −44 | 110.2 | −30 | 52.84 | −16 | 26.87 | 30 | 4.17 |
| −43 | 104.4 | −29 | 50.23 | −15 | 25.65 | 35 | 3.50 |
| −42 | 98.87 | −28 | 47.77 | −14 | 24.51 | 40 | 2.96 |
| −41 | 93.70 | −27 | 45.45 | −13 | 23.42 | 45 | 2.51 |
| −40 | 88.85 | −26 | 43.26 | −12 | 22.39 | 50 | 2.13 |
| −39 | 84.18 | −25 | 41.19 | −11 | 21.41 | 55 | 1.82 |
| −38 | 79.80 | −24 | 39.24 | −10 | 20.48 | 60 | 1.56 |
| −37 | 75.67 | −23 | 37.39 | −5 | 16.43 | 65 | 1.35 |

■Temperatures in temperature sensor (PT-100) and resistance values

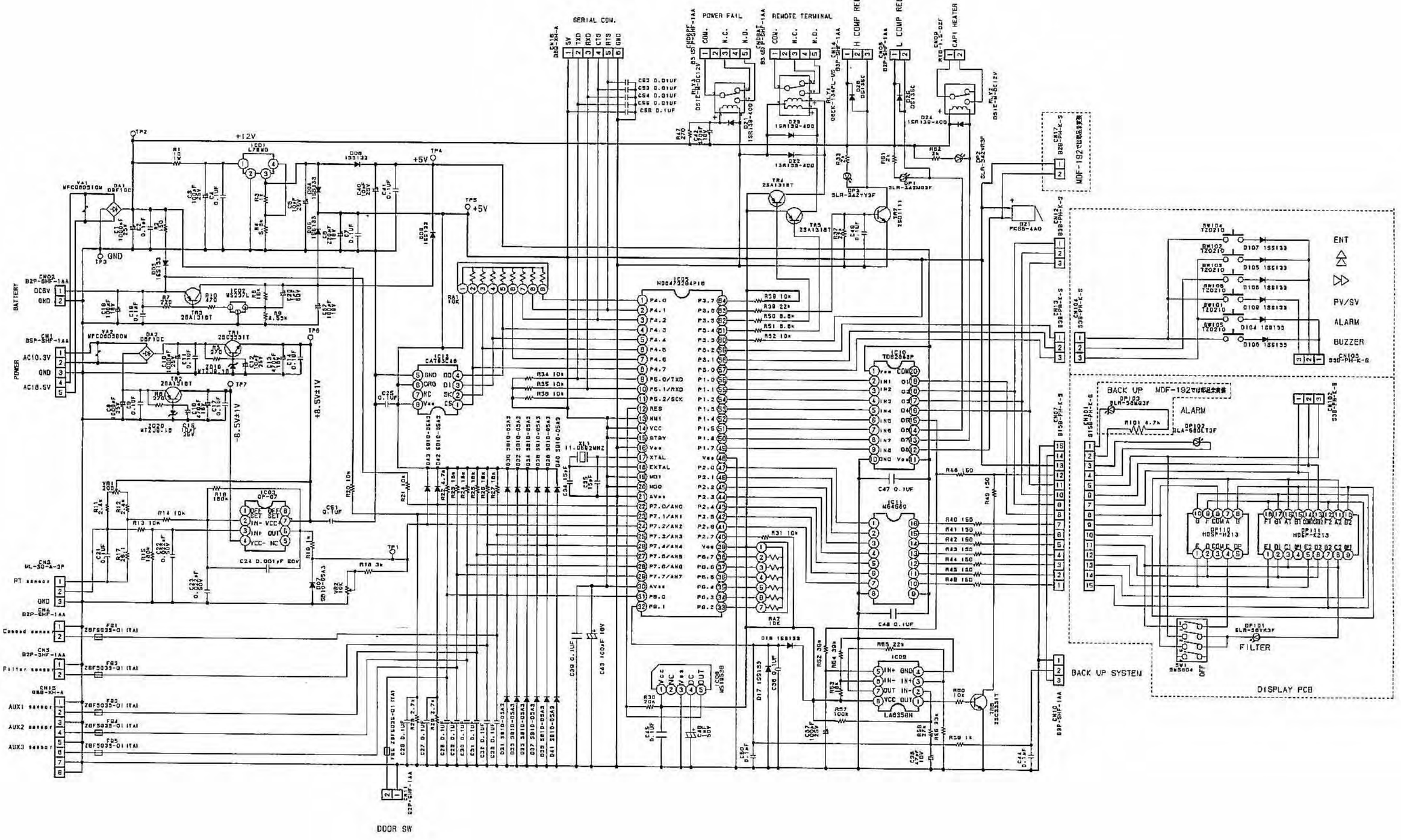
| ℃ | Ω | ℃ | Ω | ℃ | Ω | ℃ | Ω |
|---|---|---|---|---|---|---|---|
| −140 | 43.87 | −90 | 64.30 | −40 | 84.27 | 10 | 103.90 |
| −130 | 48.00 | −80 | 68.33 | −30 | 88.22 | 20 | 107.79 |
| −120 | 52.11 | −70 | 72.33 | −20 | 92.16 | 30 | 111.67 |
| −110 | 56.19 | −60 | 76.33 | -10 | 96.09 | 40 | 115.54 |
| −100 | 60.25 | −50 | 80.31 | 0 | 100.00 | 50 | 119.40 |

# Wiring Diagram




REMOTE ALARM 3P TERMINAL
POWER TRANS
AC 100V
SM2P (BK)
HARNESS E
HARNESS PS
POWER CORD
EARTH
3P TERMINAL
12P TERMINAL
HARNESS P
HARNESS F
HARNESS L
HARNESS H
TEMP CONTROL RELAY L
TEMP CONTROL RELAY H
CASCADE SENSOR
CAPITUBE HEATER
STARTING RELAY L
STARTING RELAY H
RUNNING CAP. L
STARTING CAP. L
RUNNING CAP. H
STARTING CAP. H
HARNESS CR
EL3P (W)
AT SENSOR
YL2P (W)
COMPRESSOR H
OVER LOAD RELAY H
COMPRESSOR L
OVER LOAD RELAY L
CN9
CN8
CN14
CN1
CN10
CN2
CN4
CN15
CN3
CN6 A/T
CN6 P/F
CN5
CN11
CN7
CN13
TEMP CONTROLLER
HARNESS RS
HARNESS BS
FILTER SENSOR
BATTERY SWITCH
SM2P (BK)
BATTERY
LINE LOAD
BRAEAKER SWITCH
SOLENOID VALVE
BACK UP SWITCH
AUXILIARY REF. SYSTEM
TEMP. RECORDER
TEST SWITCH
MDF-594AT, MDF-794AT ONLY
FM
CONDENSING FAN MOTOR

# Circuit Diagram



## Connection on PCB

The following shows connections of connector on Temp. Control PCB.

| Connector | Connects to | Usage | Voltage |
|---|---|---|---|
| CN1 | #1 - #2: Power transformer | To supply the power to PCB. | #1-#2: AC10.3V<br>#3: GND<br>#4-#5: AC18.5V |
| CN2 | #1 – #2: Battery | To supply the power to alarm during power failure | #1: DC6V<br>#2: GND |
| CN3 | #1 - #3: Temp. sensor | To detect internal temperature | |
| CN4 | #1 - #2: Cascade sensor | To detect cascade temperature | |
| CN5 | #1 - #2: Filter sensor | To detect temperature at condenser outlet pipe | |
| CN6 | #1 - #5 Remote switch | To output remote alarm | |
| CN7 | Display PCB | To connect with each LED | |
| CN8 | #1 - #2: Temp. control relay L | To control internal temperature | #1 - #2: 12VDC |
| CN9 | #1: Cap. tube heater<br>#2: Power supply line | To supply the power to cap. tube heater | |
| CN13 | Control PCB | To connect with each switches | |
| CN14 | #1 - #3: Temp. control relay H | To control compressor H | #1 - #3: 12VDC |
| CN15 | #1 - #2: A. T. sensor | To detect ambient temperature | |

# Control specification

**1. Key and Switch**

BUZZER : In alarm condition, buzzer stops sounding with this key pressed.
Remote alarm output and alarm message would not be off.
…… Forced to be turned off
Buzzer is not turned off during alarm test.

ALARM : With this key pressed to activate alarm test mode to be forcibly step into alarm condition (ALARM lamp blinks and intermittent buzzer sounds).

PV/SV : Press this key once to activate set mode (2nd digit in LED blinks), press the key again to revert to current internal temperature (PV) display.

▶▶ During set mode, shift between the 1st digit and the 2nd digit. In PV display, press the key over 5 seconds to display filter sensor temperature for 3 seconds. (digit of decimal point is not displayed)

▲▲ During set mode, count the blinking digit up. In PV display, press the key over 5 seconds to enter the function mode. (“F00” is displayed)
In PV display, press the key for 5 times in 5 seconds to display the value of decimal point for 3 seconds. (Ex. -80.3℃ → 803)

ENTER : During set mode, press the key to store the displayed temperature as set value (SV).

**2. Temperature control**

Setting range : -20℃～-95℃
Display range : -170℃～50℃
Setting procedure : Press PV/SV key and set the required value with ▲▲ key and ▶▶ key. Press ENTER key to memorize the set value.
Out of setting range : If you input the value out of setting range to press ENTER key, the input value would not be entered with continuous buzzer beeps. (1 second)
Note) if you press PV/SV key instead of ENTER key, set value would not be stored and automatically revert to PV display.

**3. High temperature alarm**

Setting range : +10℃ or +15℃, selectable
Setting procedure : Keep pressing ▲▲ key over 5 seconds to enter function mode (F00). Press again to count the value up. “F01” displayed to input the value of high temperature alarm. (the 1st digit blinks)
(Ex. If you want to set at 15℃ (initial 10℃), change the value to “001” and press ENTER key to store the value in non-volatile memory.

**4. Function mode**

Setting range : 00~32
Display range : 00~39
00, 02, 04, 05, 08, 12~14, 18, 19, 23, 26~30 and 33~39 are not used.
Setting procedure : In PV display, keep pressing ▲▲ key over 5 seconds to enter function mode (F00 is displayed). Change the blinking 1st digit to desired function code with ▲▲ key and ▶▶ key. Press ENTER key to be function code available.
If you input above unused function code and press ENTER key, automatically revert to PV display.

Out of setting range : Even If you input the value out of setting range and press ENTER key, the value would not be entered and automatically revert to PV display.
(Applied for function #: 33~39)
Note) If you press PV/SV key with any function mode displayed, the displayed value is ignored and automatically reverts to PV display.

**5. Warning function**

High temp. alarm : When PV is reached to SV+$SV_H$ (high temp. alarm SV) +1 or higher, ALARM lamp and LED display blinks, intermittent buzzer beeps with approx. 12 minutes of delay and remote alarm output turns on.
When PV is reached to SV+ $SV_H$ or lower, ALARM lamp and LED display go off, buzzer stops beeping and remote alarm output turns off.
If you press BUZZER key, the buzzer stops beeping instead remote alarm output does not turn off.
You can set $SV_H$ at 10℃ in F01.

Filter blockage : When the filter sensor temperature is reached to 45℃ or higher, FILTER lamp is lit.
When the filter sensor temperature is reached to 41℃ or lower, FILTER lamp goes off.

**6. Other function**

Cascade control : When the cascade temperature is reached to -34℃ or lower during pull-down, Compressor L would be turned ON.
When the cascade temperature is reached to -18℃ or higher during pull-up, Compressor H would be turned OFF.

Auto return : If there is not any key operation for 90 seconds in SV set mode and function code set mode, automatically reverts to PV mode.
Note) Auto return is not worked in F09 and F10.

**7. Function mode**

F00 Automatically revert to PV display
F01 $SV_H$ (high temp. alarm SV) setting
F03 Indication of battery accumulation time
F02, F04, F05 Automatically revert to PV display
F06 Service code input (code: 384)
F07 Temperature Zero Adjustment
F08 Automatically revert to PV display
F09 (Factory test mode …… Unused)
F10 (Factory test mode …… Unused)
F11 (Cascade temperature Zero Adjustment …… Unused)
F12~F14 Automatically revert to PV display
F15 Indication of temperature in AT sensor
F16 (Timer speed-up mode …… Unused)
F17 Model code setting (non-volatile memory initialization …… Unused)
F18, F19 Automatically revert to PV display
F20 Capillary heater is forcibly turned off
F21~F23 Automatically revert to PV display
F24 PV display (decimal point is displayed)
F25 Setting of alarm resume time
F26~F30 Automatically revert to PV display
F31 Buzzer setting during filter alarm
F32 Indication of fan motor accumulation time
F33~F39 Automatically revert to PV display

Setting procedure: In PV display, keep pressing ▲▲ key over 5seconds to display “F00”.
Input the desired function code with ▲▲ key and ▶▶ key.
Press ENTER key to be function mode available.
Note) You should input service code in F06 prior to use F07, F09~11, F15~17, F20~22, F24 and F31.
To cancel service code, input “000” in F06 or turn the power off.

F00: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in “F00” displayed to revert to PV display..

F01: <Purpose> $SV_H$ (high temp. alarm SV) setting
<Operation> Input F01 and press ENTER key to display “000” (initial value).
Set selectable “000” or “001” with ▲▲ key. Press ENTER key to store the value and revert to PV display.

F02: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in “F02” displayed to revert to PV display.

F03: <Purpose> To indicate battery accumulation time. The battery is used for lamp and buzzer operation during power failure.
<Operation> Input F03 and press PV/SV key to display battery accumulation time and “F03” alternately.
<Cancel> Input PV/SV key again to revert to PV display.

F04,05: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in “F04” (F05) displayed to revert to PV display..

F06: <Purpose> Dividing F-code for customer used from service
<Operation> Input F06 and press ENTER key to display “000” (initial value).
Set to “384” with ▲▲ key and ▶▶ key. Press ENTER key to store the value and revert to PV display.
<Cancel> Input F06 and press ENTER key to display “384”.
Change to “000” with ▲▲ key and ▶▶ key. Press ENTER key to store the value and revert to PV display.
Turn the power off then on to revert to “000”. (not stored in non-volatile memory)
Note) “384” is stored in non-volatile memory during battery back-up. (battery SW is ON)

<How to reset battery (fan motor) accumulation time>
Input F06 and press ENTER key. Input ‘409’ (‘419’ for fan motor) and press ENTER key again to reset battery (fan motor) accumulation time to show ‘000’ in F03 (F32).

F07: <Purpose> To match controlled temperature of temp. sensor with 1/2air temp.
<Operation> Input F07 and press ENTER key to display “000” (initial value).
Change to the desired value (-99~099) with ▲▲ key and ▶▶ key.
Press ENTER key to store the value and revert to PV display.
Input service code in F06 prior to use this mode.

F08: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in F08 displayed to revert to PV display.

F12~14: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in F12~14 displayed to revert to PV display.

F15: <Purpose> To indicate temperature in AT sensor
<Operation> Input F15 and press PV/SV key to display F15 and 'XXX' (present AT sensor temperature) alternately.
<Cancel> Press PV/SV key to revert to PV display.

F18~19: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in F18~F19 displayed to revert to PV display.

F20: <Purpose> To turn capillary tube heater forcibly off
<Operation> In F20 display, press ENTER key to display "000" (initial value). Change the value to "001" and press ENTER key again to turn capillary tube heater forcibly off. Unit reverts to PV display automatically.
Service code should be input in F06 prior to use this mode.

F21~23: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in F21~F23 displayed to revert to PV display.

F24: <Purpose> PV is displayed in 3 digits (digit of decimal point is displayed)
<Operation> In F24 displayed, press ENTER key to display "000" (initial value)
Change the value to "001" with ⏫ key and press ENTER key.
Ex.) -85.1℃ → 851
Service code should be input in F06 prior to use this mode.

F25: <Purpose> Setting of alarm resume time
<Operation> Input F25 and press ENTER key to display "100" (initial value).
Change the value with ⏫ key and ⏩ key.
Press ENTER key to store the value and revert to PV display.
Settable range is between 10 and 60 min. with 1 min. increment.

If you set selectable following code with BUZZER key pressed, both buzzer and remote alarm relay are turned OFF;
000: Buzzer and remote alarm don't resume
010: Buzzer and remote alarm resume with 10min. later
020: Buzzer and remote alarm resume with 20min. later
030: Buzzer and remote alarm resume with 30min. later (initial set)
040: Buzzer and remote alarm resume with 40min. later
050: Buzzer and remote alarm resume with 50min. later
060: Buzzer and remote alarm resume with 60min. later

if you set selectable following code with BUZZER key pressed, only buzzer is turned OFF;
100: Buzzer doesn't resume
110: Buzzer resumes with 10min. later
120: Buzzer resumes with 20min. later
130: Buzzer resumes with 30min. later
140: Buzzer resumes with 40min. later
150: Buzzer resumes with 50min. later
160: Buzzer resumes with 60min. later

F26~30: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in F26~F30 displayed to revert to PV display.

F31: <Purpose> Buzzer setting during filter alarm
<Operation> In F31 displayed, press ENTER key to display "001" (initial value).
Change to "000" with ⏫ key and press ENTER key to be FILTER lamp lit during filter alarm. Service code should be input in F06 prior to use this mode.

F32: <Purpose> To indicate accumulation time of condensing fan motor
<Operation> Input F32 and press PV/SV key. F32 and accumulation time (Ex.“000”) are alternately displayed. If you press ENTER key, the unit reverts to PV display.
<Cancel> Press PV/SV key to revert to PV display.

F33~39: <Purpose> Simply passing through if entered by mistake.
<Operation> Press ENTER key in F33~F39 displayed to revert to PV display.

**8. Differential (The point in which compressor turns ON and OFF )**

COMP ON: SV +0.5℃
COMP OFF: SV -0.8℃

**9. Temperature offset**

The difference between the temperature in temp. sensor and center temperature of the chamber should be adjusted by temperature offset.
Offset value; PV + 2.0℃

**10. Remote alarm**

(1) High temp. alarm (RLY 1)
In normal condition: Remote alarm contact is N.O. N.C.
↓ ↓
In alarm condition: Remote alarm contact is N.C. N.O.

(2) Power failure alarm (RLY 3)
In normal condition: Remote alarm contact is N.O. N.C.
↓ ↓
In power failure: Remote alarm contact is N.C. N.O.

**11. Sensor failure**

(1) Temp. sensor
Open circuit: E01 and 50℃ are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs.
The compressor would be allowed to turn on.
Press BUZZER key to stop the buzzer beeping.
Short circuit: E02 and -170 ℃ are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs.
The compressor would be allowed to turn on.
Press BUZZER key to stop the buzzer beeping.

(2) Cascade sensor
Open circuit: E03 and PV are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs. The resistance value would be limitless that makes the temperature -34 ℃ or lower. At the time compressor (L) is not forcibly turned off.
Press BUZZER key to stop the buzzer beeping.
Short circuit: E04 and PV are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs. The resistance value would be “0” that makes the temperature -18℃ or higher to detect an error.
Compressor (L) is forcibly turned off.
Press BUZZER key to stop buzzer beeping.

(3) Filter sensor

Open circuit: E05 and PV are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs.
Press BUZZER key to stop the buzzer beeping.

Short circuit: E06 and PV are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs.
Press BUZZER key to stop the buzzer beeping.

(4) AT sensor

Open circuit: E07 and PV are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs.
Press BUZZER key to stop the buzzer beeping.

Short circuit: E08 and PV are displayed alternately, the buzzer beeps intermittently and remote alarm contact outputs.

(5) Error code priority

No.1: Temp. sensor failure (E01 or E02)
No.2: Cascade sensor failure (E03 or E04)
No.3: Filter sensor failure (E05 or E06)
No.4: AT sensor failure (E07 or E08)
No.5: Condenser abnormal temperature (E10)

(4) Error diagnosis

E01: When PT sensor detects 50.0℃ or higher , it regards as open circuit.
E02 : When PT sensor detects -170℃ or lower, it regards as short circuit.
E03 : When cascade sensor detects -64℃ or lower, it regards as open circuit.
When cascade sensor detects 70℃ or higher, it regards as short circuit.
E04:
E05 : When filter sensor detects -50℃ or lower, it regards as open circuit.
E06 : When filter sensor detects 70℃ or higher, it regards as short circuit.
E07: When AT sensor detects -50℃ or lower, it regards as open circuit.
E08: When AT sensor detects 70℃ or higher, it regards as short circuit.
E10: When filter sensor detects 60℃ or higher, it regards as open circuit.
When filter sensor detects equal or lower than AT sensor temperature +10℃, E10 is cancelled to display.

## 12. Cycle operation for capillary tube heater

Cycle: Capillary tube heater turns on once every 12 hours
Operation time: 8 minutes
Timing: Capillary tube heater turns on regardless of compressor (L).
Compressor (L) is turned off at that time.

## 13. Compressor operation when the power is supplied (battery unattached)

Compressor (H): Once the power is supplied, compressor (H) is forcibly turned on regardless of PV.
When filter sensor detects 60℃ or higher, compressor (H) is forcibly turned off. This function is ineffective when E05 or E06 is displayed.

Compressor (L): When PV is higher than SV+0.5℃ and cascade sensor detects -34℃ or lower, the compressor (L) turns on with 2minutes (initial value) of delay after the power was supplied.
When PV is higher than SV+0.5℃ and cascade sensor detects -34℃ or higher, the compressor (L) turns on with 2minutes (initial value) of delay after the power was supplied.

Setting data: The setting data initialized in F17 is retrieved in non-volatile memory.

## 14. Lamp and buzzer

(1) Control PCB

DP1: Green lamp
When the compressor (L) is OFF, DP1 goes off. (normal status)
When the compressor (L) is ON, DP1 is lit.

DP2: Red lamp
When the capillary tube heater is OFF, DP2 goes off. (normal status)
When the capillary tube heater is ON, DP2 is lit.

DP3: Yellow lamp
Lit continuously
When the compressor (H) is ON, DP3 is lit. (normal status)
When the compressor (H) is OFF, DP3 goes off.

(2) Display PCB

DP102: Red lamp
When the unit is not in high temp. alarm condition, DP102 goes off.
When the unit is in high temp. alarm (without delay), or sensor failure, or power failure, or door open, DP102 is lit.

DP101: Red lamp
When the unit is not in filter alarm condition, DP101 goes off.
When the unit is in filter alarm condition, DP101 is lit or flash.

(3) Buzzer

| | |
|---|---|
| High temp. alarm: | Intermittent tone with 12minutes of delay |
| Sensor failure: | Intermittent tone when EXX (XX=01~08, 10) is displayed |
| Power failure: | Intermittent tone |
| Key quick: | Short tone if key quick is available |
| Out of input range: | 1second continuous tone |

## 15. Notice of timing for replacing battery/fan motor (F1: Battery F2: Fan motor)

(1) When the battery accumulation time is “028” or higher in F03, “F1” and PV are alternately displayed.

(2) When the fan motor accumulation time is “056” or higher in F32, “F2” and PV are alternately displayed.

Note: <u>You must reset battery (fan motor) accumulation time in F06 after you replace them.</u>
<u>See page p.17 how to reset.</u>

# Parts layout

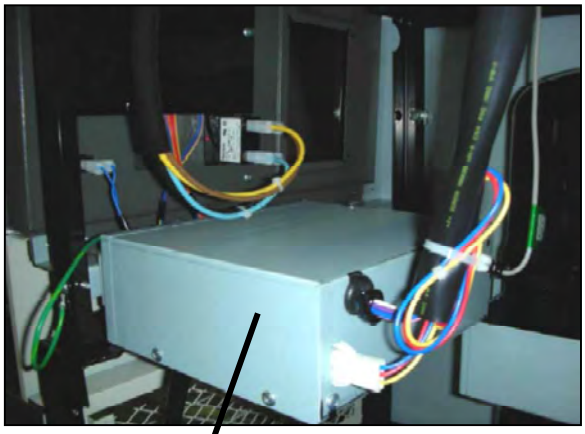
【Control panel】

Power switch
Battery switch
（CO2 back-up switch & CO2 back-up test switch for AT type only)

【Right corner - Front】

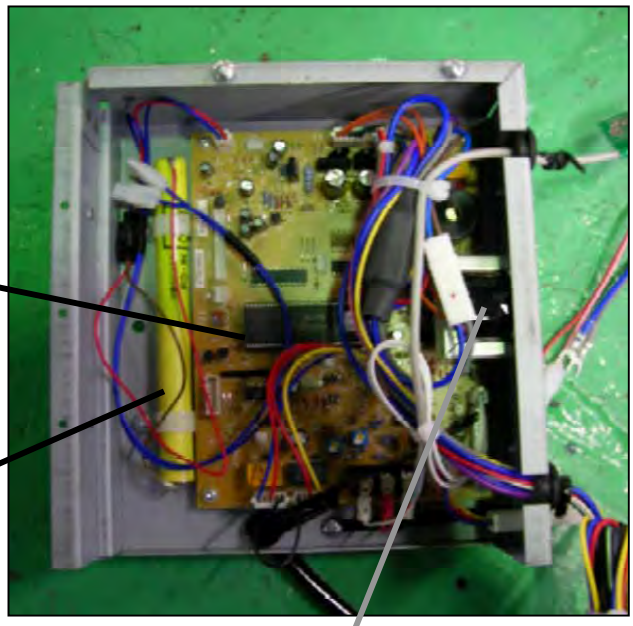
AT sensor

【Back of Control panel】



Control PCB BOX

【Control PCB BOX】



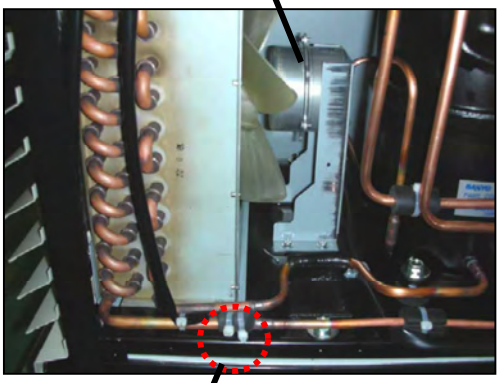
ROM

Nickel-cadmium battery

Transformer

【Unit Base】

Fan motor

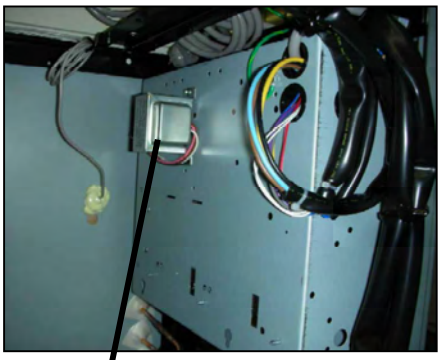


Compressor (H)

Compressor (L)

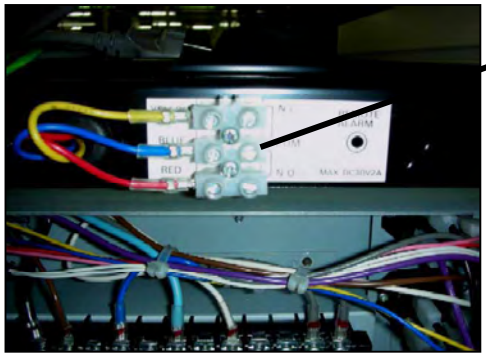
Filter sensor

【Electric BOX - Right corner】



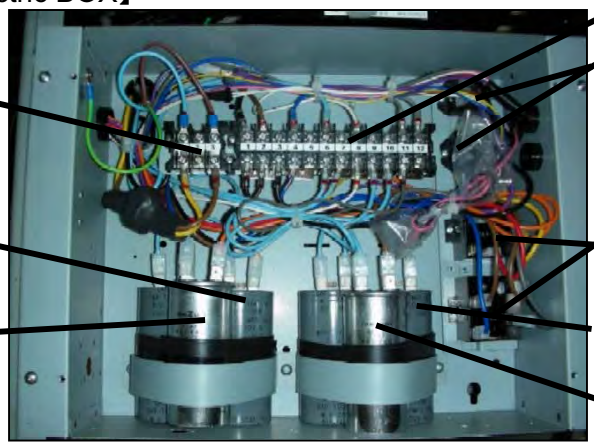
Transformer

【Remote alarm】



3P terminal

【Electric BOX】



12P terminal

3P terminal

Temp. control relay

Starting capacitor(H)

Start relay

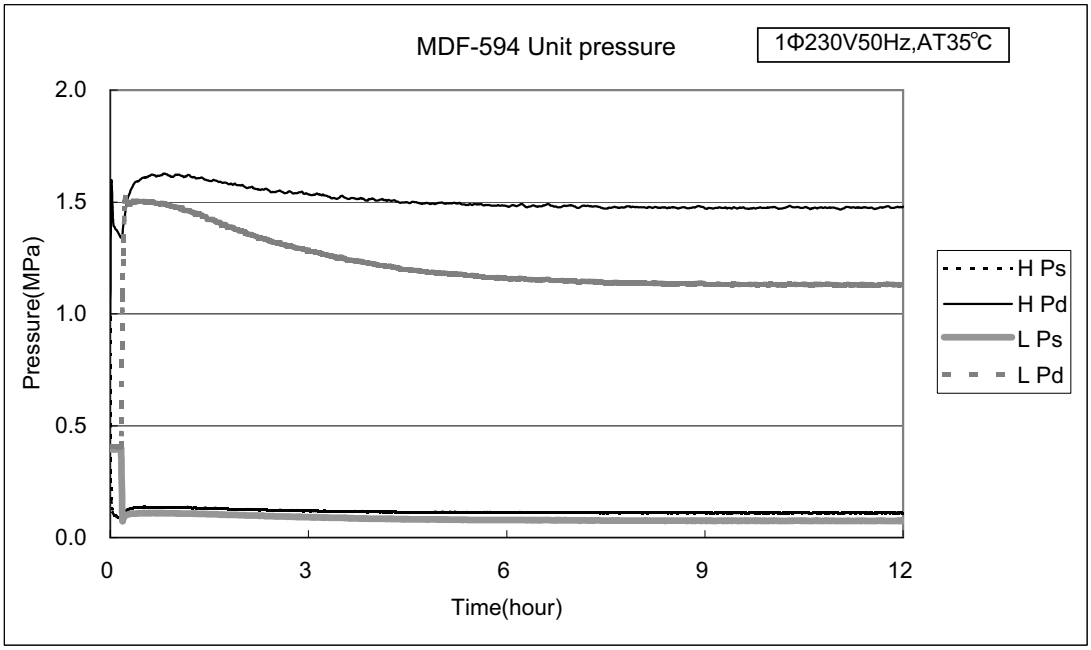
Running capacitor(H)

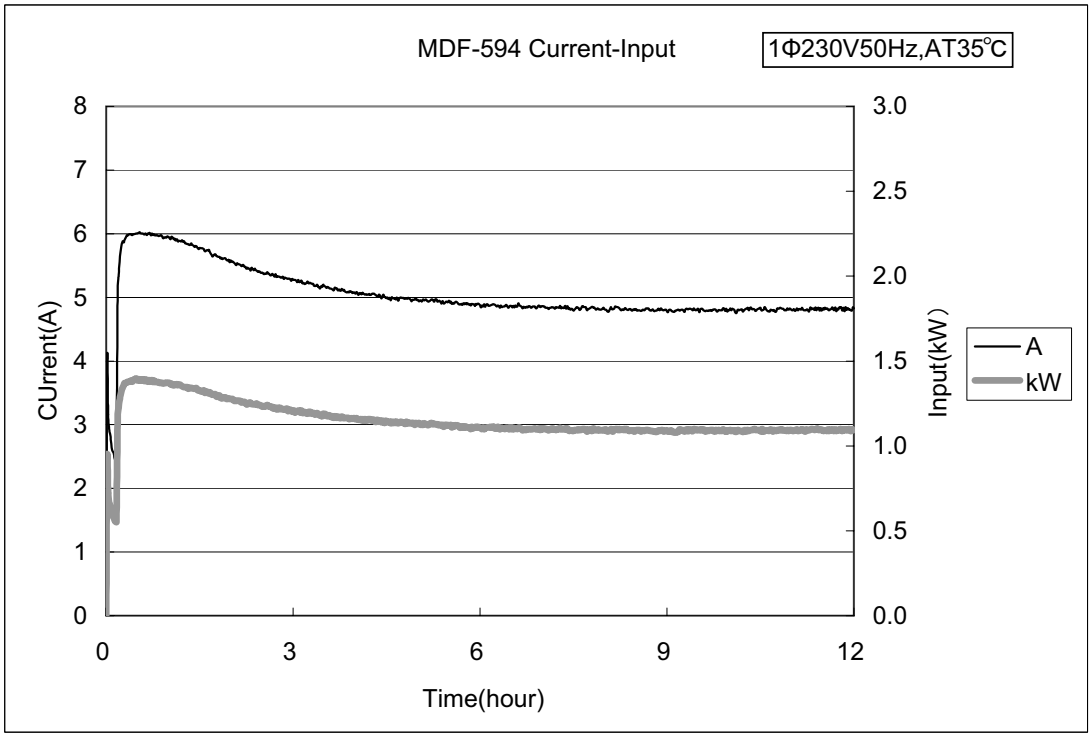
Starting capacitor(L)

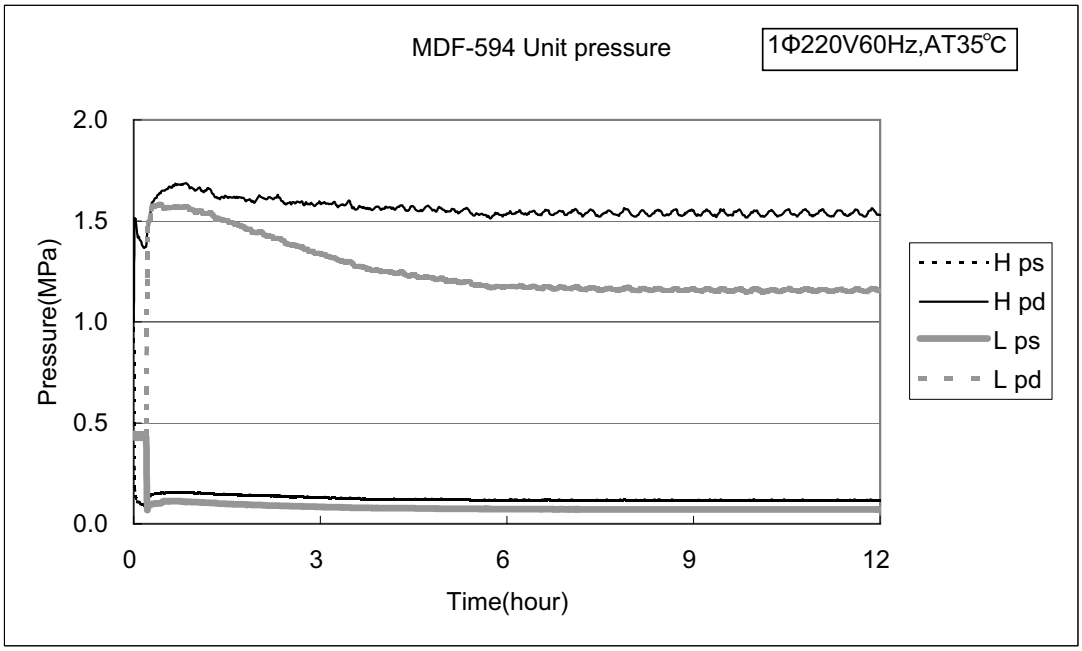
Running capacitor(L)

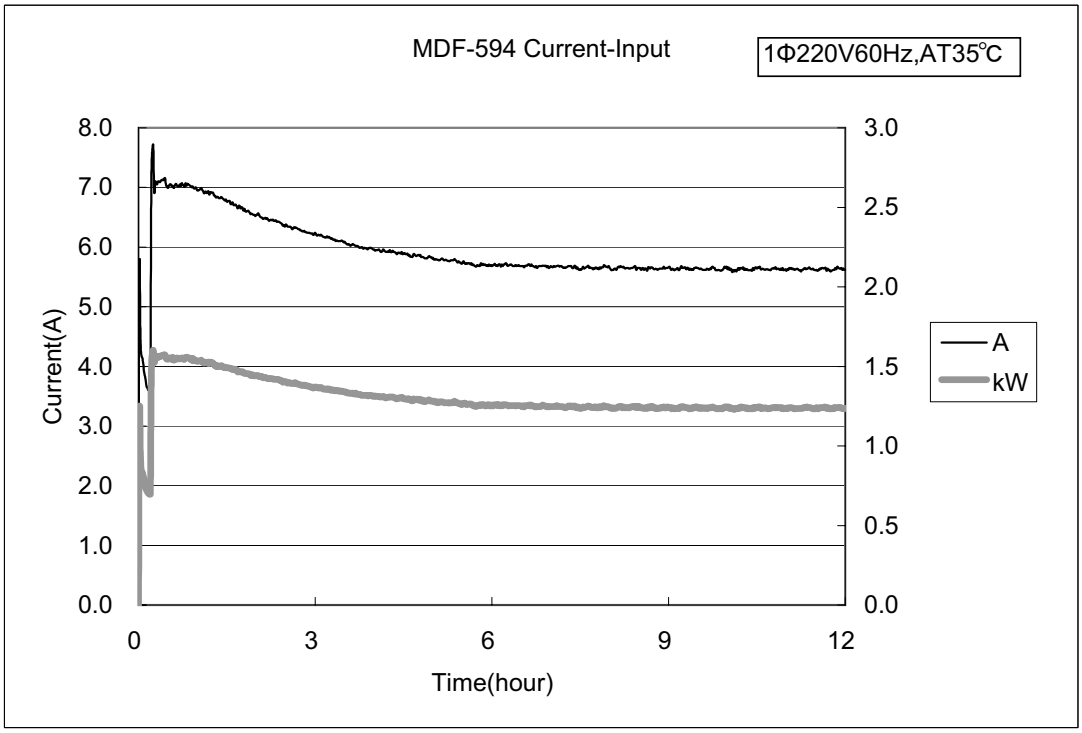
## Test data

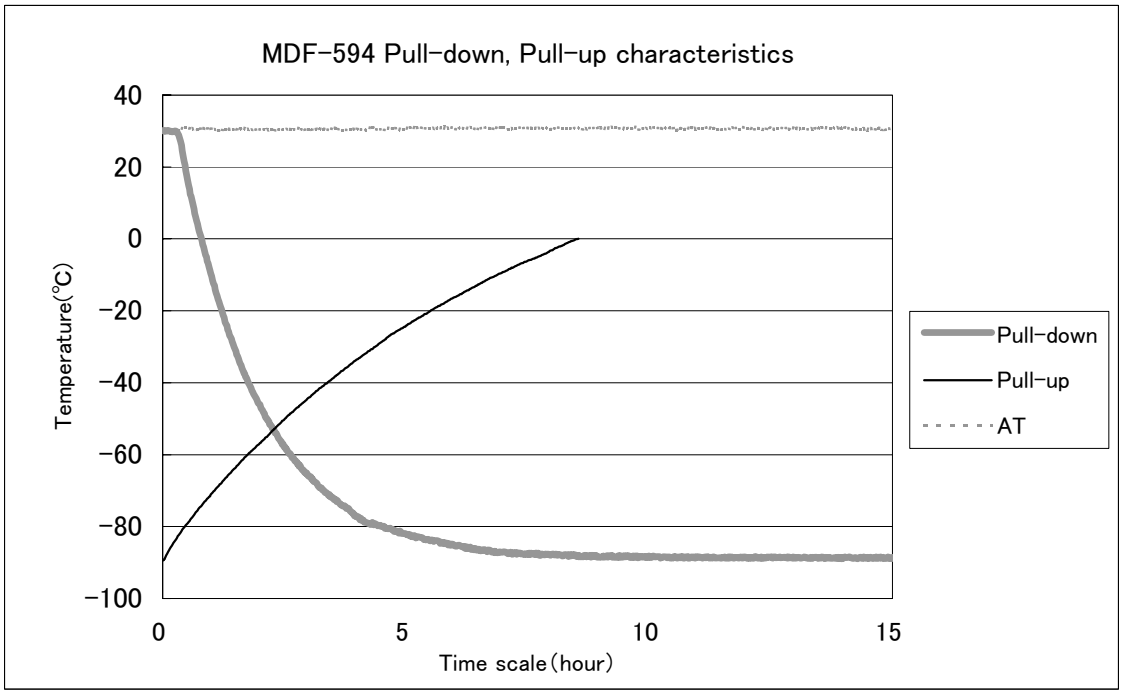
* All test data are the reference only.

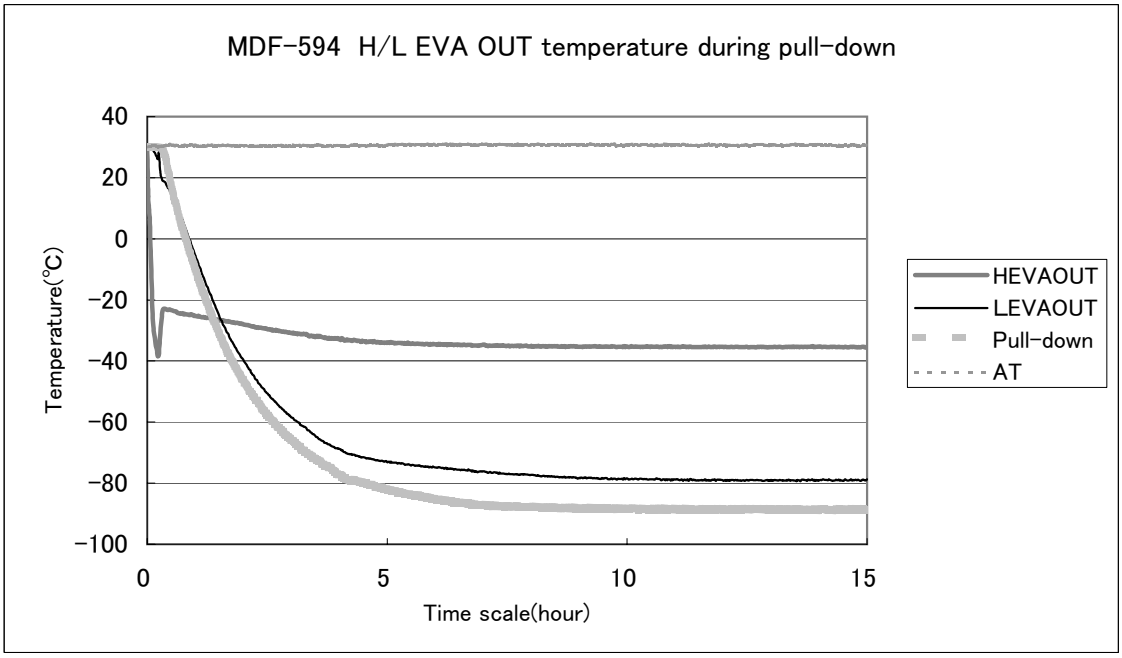



MDF-594 Unit pressure
1Φ220V60Hz,AT35℃
Pressure(MPa)
2.0
1.5
1.0
0.5
0.0
0
3
6
9
12
Time(hour)
H ps
H pd
L ps
L pd

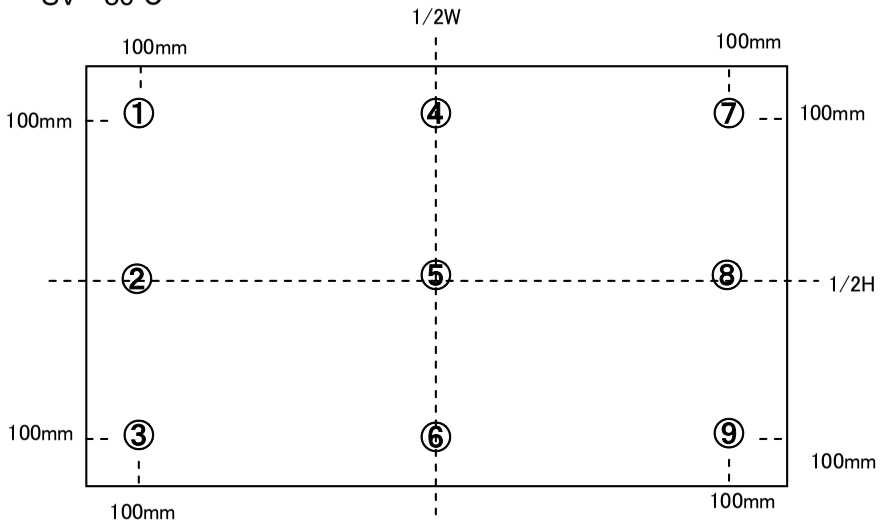

MDF-594 Current-Input
1Φ220V60Hz,AT35℃
Current(A)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
3
6
9
12
Time(hour)
A
kW


MDF-594 Pull-down, Pull-up characteristics
40
20
0
-20
-40
-60
-80
-100
Temperature(℃)
0
5
10
15
Time scale(hour)
Pull-down
Pull-up
AT


MDF-594 H/L EVA OUT temperature during pull-down
40
20
0
-20
-40
-60
-80
-100
Temperature(℃)
0
5
10
15
Time scale(hour)
HEVAOUT
LEVAOUT
Pull-down
AT

## MDF-594 Chamber temperature uniformity

Conditions: AT=30℃
230V,50Hz
SV=-80℃




Measuring points

| Point | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ |
|---|---|---|---|---|---|---|---|---|---|
| Temp.(℃) | -77.1 | -78.9 | -79.8 | -78.1 | -78.8 | -79.1 | -78.3 | -79.1 | -79 |

* Display temperature range; -79~-81℃

Note) Above data is the reference only.